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ABSTRACT

Stressing the importance of engineers to the growth of the economy, the building of national defense, and the preparation of future generations for a technological age, this report examines the changes in engineering degree awards from 1972-1984. The document describes these changes from four perspectives. The role of graduates from United States colleges in replenishing and building the engineering labor pool is addressed with regard to the changes in supply and demand. Next, the numbers of degree awards at the bachelors, masters, and doctoral degree levels are traced during that period and the areas of engineering specialty that those graduates represent are described. Engineering degree recipients are further discussed with regard to the representation of women, racial and ethnic minorities, and students from foreign countries. Finally, the top 20 institutions of higher education in the production of engineering graduates are listed, and the distribution of engineering degrees by level and by control of the institution in 1984 is outlined. (TW)

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Trends in Engineering Degree Awards: 1972 - 1984

Why is it important to examine the production of engineering graduates from our colleges and universities? Engineers compose just 3.4 percent of the workforce in the United States, and engineering faculty compose about 2 percent of all postsecondary teaching faculty.[1] Even though engineers represent a small proportion of the labor force, their work is of major importance to the Nation. It is critical to the growth of the American economy, to the building of national defense, and to the preparation of future generations for a technological age.[2]

This report is about the changes in engineering degree awards during the 1970's and early 1980's from 4 perspectives:

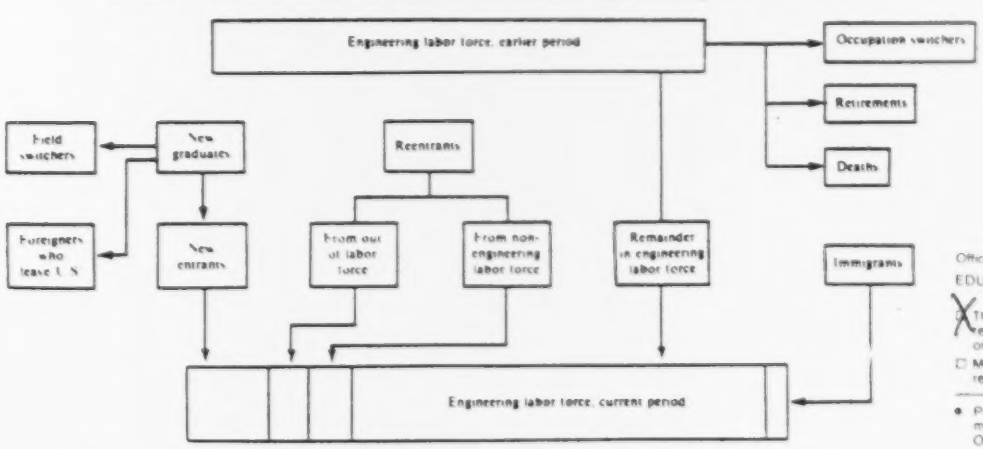
1. The role of graduates from U.S. colleges in replenishing and building the engineering labor pool;
2. Trends in degree awards by level and specialties;
3. Participation by women, racial minorities, and foreign students; and
4. Institutions of higher education prominent in producing graduates in engineering.

This trend analysis is based on data collected by the Center for Education Statistics from all colleges and universities on degree awards in the field of engineering and for specialties in this field. Data from sample surveys, primarily from the National Science Foundation (NSF), are also included.

Engineering Graduates and the Engineering Labor Force

The demand for engineering expertise grew rapidly in the 1950's and 1960's, and continued at a slower pace in the 1970's and 1980's. Attention is being focussed on whether the Nation's colleges are meeting the demand for professionals in the engineering field. Chart I provides a diagram of the occupational labor market flows for the engineering labor force, and the place new graduates from U.S. colleges have in replenishing and building this labor pool.

Chart 1.—Labor market flows for the engineering labor force



Note: Size of box has no relation to the size of the estimate.
Source: National Science Foundation, *Science and Engineering Personnel: A National Overview*. Washington, D.C., National Science Foundation, 1980, p. 16, adjusted by CES for this report.

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Graduates of American colleges and universities are the primary source of new engineers. Most engineers enter the labor force with only baccalaureate preparation. However, not all persons with baccalaureates in engineering enter the labor pool of engineers. Some graduates with engineering degrees do not become engineers. Based on a 1982 follow-up survey of 1980 bachelor's degree recipients, it was estimated that 15 percent of engineering graduates were employed outside the engineering field.[3] Also, some foreign students leave for their home country after earning an engineering degree in the United States. Although it is not known what proportion of foreign baccalaureate graduates stayed in the United States to work, it is known that more foreign *doctoral* graduates are remaining in this country to work (13 percent in 1972; 37 percent in 1984).[4]

Graduates from American colleges and universities who became engineers would not account for all the entrants into the engineering labor pool. Immigrants with degrees from colleges outside the United States compose a small but growing proportion of the engineering work force, and in 1982, composed 18 percent of all full-time engineering faculty.[5] Other sources are persons who re-entered the engineering work force, and those who became engineers even though they had earned a degree in another field. Again, from the 1982 follow-up survey of 1980 bachelor's degree recipients employed full-time, it was estimated that 20 percent of those who were employed as engineers had earned their degree in other fields.[6]

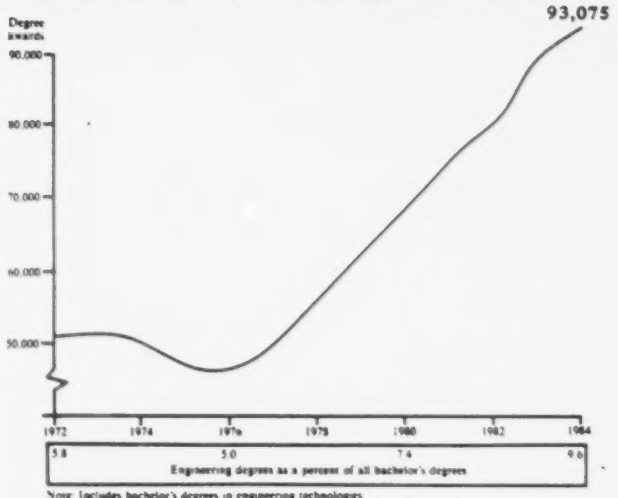
Engineering Degree Awards

From academic year 1971-72 to 1983-84,[7] the number of degree awards in engineering increased from 72,000 to 116,000. However, there were declines for some years during this period at the bachelor's, master's, and doctoral levels.

Bachelor's Degrees

The number of bachelor's degrees in engineering declined from 1973 to 1976. Then from 1976 to 1984, the number increased almost 75 percent (chart 2). Demography accounts for only a small proportion of this growth, as the college-age population 18-24 years old increased only 7 percent in this period.[8] Most of the increase was from more college students choosing engineering as their major. This is reflected in the proportion of all bachelor's degrees awarded in engineering in 1972, 1976, and 1984 (chart 2).

Chart 2.—Bachelor's degrees awarded in engineering: 1972 to 1984

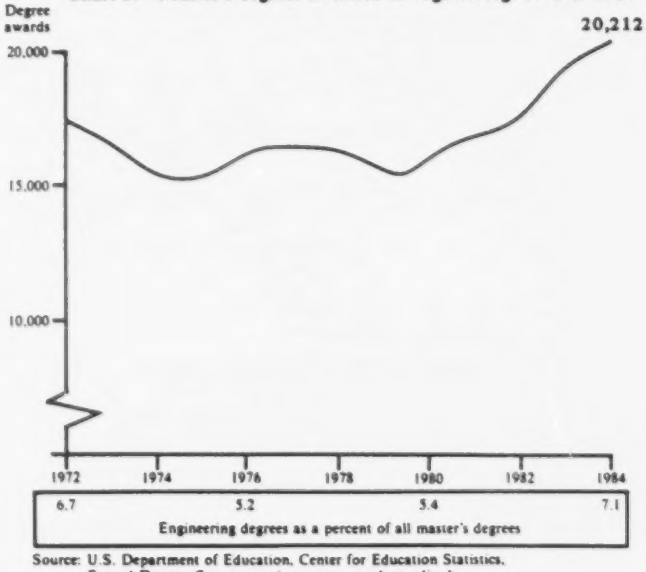


Note: Includes bachelor's degrees in engineering technologies.
Source: U.S. Department of Education, Center for Education Statistics, Earned Degrees Surveys, various years, see appendix table A.

Master's Degrees

At the master's degree level, engineering awards declined from 17,000 in 1972 to 15,400 in 1975. From 1976 through 1980, master's degree awards remained stable at about 16,300 annually, then increased to more than 20,000 by 1984 (chart 3).

Chart 3.—Master's degrees awarded in engineering: 1972 to 1984



Source: U.S. Department of Education, Center for Education Statistics, Earned Degrees Surveys, various years, see Appendix A.

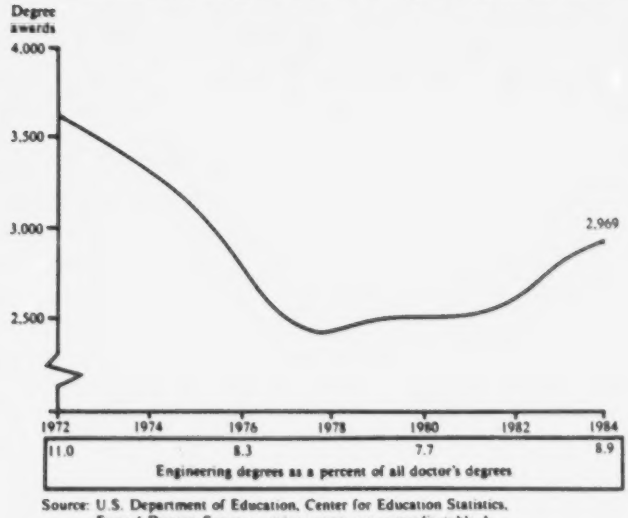
The trends for engineering master's degrees were opposite those for master's degrees in general. In the early 1970's when total master's degree awards were increasing, engineering awards were decreasing. In the late 1970's and early 1980's when total master's degrees were declining, engineering awards were slowly rising.

The number of master's degrees awarded in engineering increased slightly in the late 1970's and early 1980's, but the increase was not nearly as steep as the increase in baccalaureates. Until 1977, the ratio of bachelor's degrees to master's degrees was about 3 to 1. Between 1977 and 1984, it increased to a ratio of 5 to 1.

Doctor's Degrees

The number of doctor's degrees in engineering declined from about 3,700 in 1972 to 2,400 in 1978, then began to increase slowly, reaching almost 3,000 by 1984 (chart 4).

Chart 4.—Doctor's degrees awarded in engineering: 1972 to 1984



Source: U.S. Department of Education, Center for Education Statistics, Earned Degrees Surveys, various years, see appendix table A.

Engineering Specialties

These trends for all engineering degrees were generally reflected in the 25 engineering specialties. (Appendix table B has data on each specialty in 1972 and 1984.)

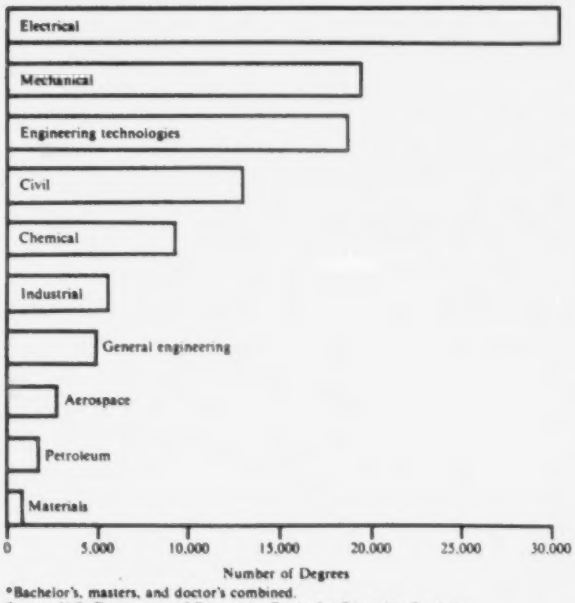
The largest specialty by far is electrical engineering (including electronics and communications). It represents a fourth of all engineering degree awards. Electrical engineering is followed in rank by mechanical engineering, engineering technologies, and civil engineering (chart 5). These 4 specialties accounted for 70 percent of all engineering degrees in 1984.

Participation of Selected Groups

Although the number of white male engineering degree recipients increased from 50,000 to 71,000 from 1976 to 1983, they were a declining proportion of the total graduates in engineering (table 1).

Meanwhile, there were significant increases in the participation of foreign students and Asian-Americans. Blacks and Hispanics had marginal increases, and American Indians remained stable in their proportional representation in engineering. With the exception of Asian-Americans, minority groups are underrepresented in engineering.[9]

Chart 5.—Top 10 specialties in engineering ranked by total degrees* in 1984



*Bachelor's, masters, and doctor's combined.
Source: U.S. Department of Education, Center for Education Statistics, Earned Degrees Survey, 1983-84, appendix table B.

Table 1.—Representation of selected groups among engineering graduates (1976 and 1983) and among the U.S. population (1980)

Selected groups	Representation among engineering graduates[1]		Representation in U.S. population (1980 Census)
	1976	1983	
	(in percent)		
White men	78.4	63.6	40.5
Foreign students	11.9	12.8	(2)
Asians	2.5	11.6	1.6
Blacks	2.6	2.9	11.7
Hispanics	1.7	2.0	6.4
American Indians	0.3	0.3	0.7

[1]Bachelor's, masters, and doctor's degrees combined.
[2]Not available.
Source—U.S. Department of Education, Center for Education Statistics and the Office for Civil Rights, Earned Degrees Surveys 1975-76 and 1982-83, unpublished tabulations; U.S. Department of Commerce, Bureau of the Census, *We, The Americans.* Washington, D.C. U.S. Government Printing Office, 1984, p. 8, for data on representation in U.S. population.

Participation of Women

Since 1972, one of the most dramatic changes in engineering education was the increase in the participation of women. However, despite increases during the decade, women are still substantially underrepresented in engineering.

In 1972, about 1 percent of all engineering degrees were awarded to women; by 1984, women received 12 percent of engineering degrees. This varied by degree level, with representation of women at the doctoral level much lower than at the bachelor's or master's level (table 2).

Table 2.—Engineering degrees awarded to women, by level of degree: 1972 and 1984

Degree level	Women engineering graduates			
	Number		Percent of engineering degrees	
	1972	1984	1972	1984
Total	820	14,385	1	12
Bachelor's	530	12,060	1	13
Master's	270	2,155	2	12
Doctor's	20	165	1	6

Source—U.S. Department of Education, Center for Education Statistics, Earned Degrees Surveys, 1971-72 and 1983-84, appendix table B.

The distribution of women graduates among engineering specialties differs from that for men. Compared with men, a lower proportion of women chose electrical engineering and mechanical engineering, while a higher proportion of women chose chemical engineering and industrial engineering. In 1984, women were about a fourth of the graduates in chemical and industrial engineering. (Appendix table B shows the proportion of women in every engineering specialty.)

Racial/Ethnic Minorities

U.S. colleges and universities educate more foreign students in engineering than U.S. racial/ethnic minority students. In 1983, U.S. students who were Asian, black, Hispanic, or American Indian accounted for about 11,160 of all engineering degree awards, compared with approximately 13,290 degrees awarded to foreign students.

Among U.S. minority groups, the participation of blacks, Hispanics, and American Indians has differed generally from that of Asians. From 1976 to 1983 there were increases in engineering awards among all racial/ethnic groups at the bachelor's level. At the post-baccalaureate levels there was a decrease for American Indians, small increases for black and Hispanic graduates, and large increases for Asian graduates. Asians represented at least half of all minority graduates at each degree level in 1983.

More information is available in biennial reports on women and minorities in science and engineering published by the National Science Foundation.[10]

Table 3.—Engineering degrees awarded to minorities, by racial/ethnic group and level of degree: 1976 and 1983

Degree level and year	Racial/ethnic groups[1]				
	Black	Hispanic[2]	American Indian	Asian	White
Bachelor's					
1976	1,370	840	150	970	38,970
1983	2,850	1,880	210	3,760	69,070
Difference	1,480	1,040	60	2,790	30,100
Master's					
1976	230	230	40	500	11,410
1983	360	320	36	1,480	10,590
Difference	130	90	4	980	-820
Doctor's					
1976	19	17	3	120	1,660
1983	25	37	9	220	1,240
Difference	6	20	6	100	-420

[1]Excludes foreign students.
[2]May be of any race; Hispanics are not included in the other groups.
Source—U.S. Department of Education, Center for Education Statistics and the Office for Civil Rights, Earned Degrees Surveys, 1975-76 and 1982-83, unpublished tabulations. Numbers rounded to tens where possible.

Students from Foreign Countries

Engineering has been a popular choice among foreign students in the United States to obtain a college degree. Since 1970, the *proportion* of foreign students who major in engineering has remained about 22 percent.[11] However, the number of foreign engineering students increased because the number of foreign students studying in this country increased.[12]

Between 1976 and 1983, the number of foreign students receiving engineering degrees increased at all levels. By 1983, foreign graduates accounted for almost 1 of 10 baccalaureates, 3 of 10 master's degrees, and 4 of 10 doctorates in engineering (table 4).

Data on the engineering specialties in which foreign graduates receive degrees are only available at the doctoral level. National Research Council data show that foreign students earned 63 percent of the doctorates in civil engineering, and 61 percent of the doctorates in mechanical engineering and industrial engineering.[13]

Two-thirds of the engineering doctorates awarded to non-U.S. citizens in 1984 were awarded to persons from East and West Asia. China and India accounted for a third of the doctorates awarded to foreign students.[14]

Prominent Institutions in the Production of Engineering Graduates

The number of colleges and universities awarding engineering degrees has continued to increase since 1949 when the Federal government started publishing annual reports on engineering degrees.[15]

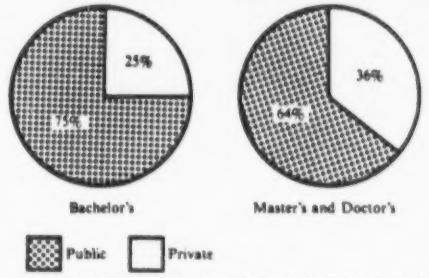
Number of engineering schools awarding degrees, by year (rounded to the nearest 5)

Year	1952	1962	1972	1984
Number	195	245	415	505

From 1972 to 1984, the number of colleges offering engineering increased from 415 to 505. By 1984, a third of the 4-year colleges in this country had engineering schools.

At the bachelor's degree level, public institutions conferred three-fourths of engineering degrees. At the post-baccalaureate level, they conferred about two-thirds of the engineering degrees (chart 6).

Chart 6.—Distribution of engineering degrees by level and by control of institution: 1984



Source: U.S. Department of Education, Center for Education Statistics, Earned Degrees Survey, 1983-84.

Seventeen universities and 3 specialized engineering institutions awarded a fourth of all the engineering degrees in the United States. Each of the largest 20 engineering schools produced at least 1,000 engineering graduates in 1984.

Table 4.—Engineering degrees awarded to foreign students, by level of degree: 1971, 1976, and 1983

Degree level	Engineering degrees awarded to foreign students					
	Numbers			Percent of total degrees in engineering		
	1971	1976	1983	1971	1976	1983
Bachelor's	1,565	3,170	6,885	4	7	8
Master's	2,930	3,490	5,244	18	22	27
Doctor's	741	960	1,161	20	35	41

Sources—U.S. Department of Education, Center for Education Statistics, Earned Degrees Surveys for 1975-76 and 1982-83 data; Engineering Manpower Commission for 1971 data.

Top 20 institutions in the number of engineering degrees conferred in 1984

1. Purdue University (IN)
2. Texas A&M University
3. Pennsylvania State University
4. University of Michigan - Ann Arbor
5. Georgia Institute of Technology*
6. University of Illinois - Urbana
7. Massachusetts Institute of Technology
8. Va. Polytechnic Institute and State University
9. University of Texas - Austin
10. University of California - Berkeley
11. North Carolina State University - Raleigh
12. Stanford University (CA)
13. University of Wisconsin - Madison
14. University of Missouri - Rolla*
15. Ohio State University
16. Northeastern University (MA)
17. Michigan Technological University*
18. Rensselaer Polytechnic Institute (NY)
19. University of Minnesota, Minneapolis - St. Paul
20. University of Florida

*Institutions emphasizing engineering, usually awarding over half of their degrees in this field.

Source—U.S. Department of Education, Center for Education Statistics, Earned Degrees Survey, 1983-84.

If more information is needed on engineering education and the engineering labor force, the National Research Council has published a comprehensive report on the strengths and weaknesses of engineering education, major trends in the engineering work force, and a preview of engineering in the year 2000.[16]

Table A.—Degrees in engineering and engineering technologies, by level of degree: 1972 through 1984

Academic year ending:	Bachelor's	Master's	Doctor's
1972	51,164	16,960	3,671
1973	51,265	16,619	3,492
1974	50,286	15,379	3,312
1975	46,852	15,348	3,108
1976	46,331	16,342	2,821
1977	49,283	16,245	2,586
1978	55,654	16,398	2,440
1979	62,375	15,495	2,506
1980	68,893	16,234	2,507
1981	75,000	16,709	2,561
1982	80,005	17,939	2,636
1983	89,199	19,350	2,831
1984	93,075	20,212	2,969

Source— U.S. Department of Education, Center for Statistics, Earned Degrees Surveys, various years.

Table B.—Degree awards in all disciplines, engineering, and in engineering specialties by level, with percent awarded to women: 1972 and 1984

Degree level	Academic year ending		Percent awarded to women	
	1972	1984	1972	1984
Total degrees in all disciplines				
Bachelor's	887,273	970,483	44	51
Master's	251,633	282,905	41	50
Doctor's	33,363	33,253	16	34
Total degrees in engineering				
Bachelor's	51,164	93,075	1	13
Master's	16,960	20,212	2	11
Doctor's	3,671	2,969	1	6
Engineering specialties: (ranked by total degrees in 1984)				
Electrical, electronics, and communications				
Bachelor's	12,101	24,925	1	9
Master's	4,206	4,913	1	8
Doctor's	824	584	*	2
Engineering and engineering-related technologies				
Bachelor's	5,720	18,602	1	8
Master's	237	551	*	11
Doctor's	15	2	0	0
Mechanical				
Bachelor's	8,350	16,426	*	11
Master's	2,282	2,755	1	7
Doctor's	411	319	*	2
Civil				
Bachelor's	6,803	9,555	1	14
Master's	2,487	3,145	2	10
Doctor's	415	369	*	7
Chemical				
Bachelor's	3,625	7,475	2	25
Master's	1,154	1,514	2	13
Doctor's	394	330	*	6
Industrial				
Bachelor's	3,680	3,937	1	27
Master's	1,731	1,557	1	18
Doctor's	168	119	0	14
General engineering				
Bachelor's	2,925	3,493	2	18
Master's	991	1,230	2	12
Doctor's	284	296	1	2

*Less than 0.5 percent.

continued

Table B.—Degree awards in all disciplines, engineering, and in engineering specialties by level, with percent awarded to women: 1972 and 1984, continued

Degree level	Academic year ending		Percent awarded to women	
	1972	1984	1972	1984
Aerospace, aeronautical, astronautical				
Bachelor's	2,180	2,325	1	7
Master's	687	462	1	6
Doctor's	197	106	0	2
Petroleum				
Bachelor's	304	1,634	1	11
Master's	105	281	1	5
Doctor's	20	21	0	0
Agricultural				
Bachelor's	447	735	*	8
Master's	117	142	0	11
Doctor's	65	44	0	2
Metallurgic				
Bachelor's	579	654	1	22
Master's	264	283	1	11
Doctor's	127	98	2	14
Bioengineering and biomedical				
Bachelor's	65	540	6	28
Master's	88	245	5	27
Doctor's	46	51	0	18
Mining and mineral				
Bachelor's	169	524	1	7
Master's	76	91	0	4
Doctor's	36	12	3	0
Naval architecture and marine				
Bachelor's	304	464	*	4
Master's	51	92	4	5
Doctor's	6	5	0	0
Nuclear				
Bachelor's	312	421	2	9
Master's	383	285	2	4
Doctor's	120	114	2	5
Architectural				
Bachelor's	253	411	2	13
Master's	23	40	0	5
Doctor's	0	5	0	0
Materials				
Bachelor's	116	394	5	25
Master's	165	301	3	22
Doctor's	96	152	0	9
Geological				
Bachelor's	111	381	5	18
Master's	40	44	0	11
Doctor's	17	8	0	0
Engineering mechanics				
Bachelor's	210	349	1	14
Master's	269	167	3	9
Doctor's	147	67	1	4
Engineering physics				
Bachelor's	469	327	2	8
Master's	78	37	3	11
Doctor's	30	22	0	5
Ceramic				
Bachelor's	196	304	2	26
Master's	60	100	7	19
Doctor's	19	17	5	6
Environmental health				
Bachelor's	96	190	4	32
Master's	359	360	3	24
Doctor's	41	36	5	6
Ocean				
Bachelor's	164	109	3	1
Master's	77	95	5	7
Doctor's	9	9	0	0
Geophysical				
Bachelor's	65	103	3	15
Master's	7	11	0	9
Doctor's	7	5	0	20
Textile				
Bachelor's	65	40	6	40
Master's	21	11	0	27
Doctor's	3	1	0	0
Other				
Bachelor's	1,623	3,912	3	18
Master's	942	1,504	4	13
Doctor's	174	177	2	13

*Less than 0.5 percent.

Note— Data for 1972 and 1984 were collected under different classifications of instructional programs; therefore 1972 data were correlated with the classification used for the 1984 data.

Source— U.S. Department of Education, Center for Education Statistics, Earned Degrees Survey for 1971-72 and 1983-84, unpublished tabulations.

Notes

[1]U.S. Department of Commerce, Bureau of the Census, *1980 Census of the Population, Earnings by Occupation and Education.* Washington, D.C., U.S. Government Printing Office, 1984.

[2]U.S. Congress, Office of Technology Assessment, *Demographic Trends and the Scientific and Engineering Workforce—A Technical Memorandum.* Washington, D.C., OTA, 1985, pp. iii and 3.

[3]National Science Foundation, *Science and Engineering Personnel: A National Overview.* Washington, D.C.: National Science Foundation, 1985, p. 31.

[4]National Science Foundation, *Foreign Citizens in U.S. Science and Engineering, History, Status, and Outlook.* Washington, D.C.: National Science Foundation, 1985, p. 169.

[5]Op. cit., *Demographic Trends and the Scientific and Engineering Workforce,* p. 30.

[6]*Ibid.*, p. 158.

[7]Data for academic year 1983-84 are the latest available. Academic years will be referred to hereafter by the year they end. For example, academic year 1983-84 will be referred to as 1984.

[8]U.S. Department of Commerce, Bureau of the Census, Current Population Survey, *School Enrollment—Social and Economic Characteristics of Students: October 1984.* Washington, D.C.: U.S. Government Printing Office, 1985, p. 4.

[9]National data on racial/ethnic minorities are limited because the Federal government did not collect degree data by race before 1976. These data are collected biennially so the most recent year for these is the 1982-83 academic year. Also, the Federal government does not collect data on subfields by race, but these data are available annually from the Engineering Societies, Inc., 415 Second Street N.E., Washington, D.C. 20002.

[10]National Science Foundation, *Women and Minorities in Science and Engineering,* Washington, D.C.: National Science Foundation, 1986.

[11]Institute for International Education, *Profiles: The Foreign Student in the United States.* New York, New York, Institute for International Education, 1983.

[12]Institute for International Education, *Open Doors 1984/1985,* New York, New York, Institute for International Education, 1985.

[13]Op. cit., *Foreign Citizens in U.S. Science and Engineering History, Status and Outlook,* p. 160.

[14]*Ibid.*, p. 163, calculations by Center for Education Statistics.

[15]U.S. Department of Health, Education and Welfare, National Center for Education Statistics, "Engineering Degrees and Enrollment," 17th Annual Report, Washington, D.C., National Center for Education Statistics, 1967, p. 2.

[16]National Research Council, *Engineering Education and Practice in the United States, Foundations of our Techno-Economic Future.* Washington, D.C.: National Academy Press, 1985.